REAL TIME VIDEO PROCESSING FOR DRONE-BASED LIGHTNING SENSOR

MUHAMMAD FIKRI BIN AZIZ

This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree of Electronic Engineering (Computer Engineering) (Hons.)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

June 2017

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : REAL TIME VIDEO PROCESSING FOR DRONE-BASED LIGHTNING SENSOR

Sesi Pengajian : 1 6 / 1 7

Saya **MUHAMMAD FIKRI BIN AZIZ** mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (**√**) :

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

MUHAMMAD FIKRI BIN AZIZ

Tarikh : .....

DR. MOHD RIDUAN B. AHMAD

Tarikh : .....

Tarikh: .....

Tarikh: .....

DECLARATION

I hereby, declared this report entitled

REAL TIME VIDEO PROCESSING FOR DRONE-BASED LIGHTNING SENSOR

is the results of my own research except as cited in references.

Signature	:	…….
Author‟s Name	:	MUHAMMAD FIKRI BIN AZIZ
Date	:	……

APPROVAL

This report is submitted to the Faculty of Electronic Engineering and Computer Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering (Computer Engineering) (Hons.). The member of the supervisory is as follow:

Signature	:	…….
Supervisor‟s Name	:	DR. MOHD. RIDUAN B. AHMAD
Date	:	……

Dedicated to my mother, Rofiah binti Ayob.

And shout out to all BBNet members for being awesome.

ACKNOWLEDGEMENT

First, foremost and most importantly, I express my most thankful to The Most Merciful, The Most Powerful and The Most Beneficent, Allah Subhanahu wa Ta'ala that has provided for me with the opportunity to finish this final year project.

I also would like to express my sincere gratitude to my supervisor Dr. Mohd. Riduan bin Ahmad for the continuous support for my Bachelor Degree study and research, for her patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better supervisor for my Bachelor Degree study

Shout out to all my peers, my family, and siblings for their moral support in completing this project. Lastly, thank to everyone who had been to the crucial parts of realization of this project.

ABSTRACT

The development of real time video processing for drone-based lightning sensor by using raspberry pi is described. Lightning has become a riddle and phenomenal among researchers. Research on the impact of lightning on Earth continues today. The pattern, the colour, the dimension size and the characteristic is a famous question hanging unanswered, especially focusing on intra-cloud lightning, Narrow Bipolar Event (NBE). Detecting lightning activity in the geological record can be difficult, given the instantaneous nature of lightning strikes in general anytime. Earth scientists are interested in detecting lightning because it helps pinpoint where and when the lightning is occurring. Thus, detecting lightning strikes is important to improve public safety during severe weather, warning land managers of possible wildfire triggers, and protecting electrical and transportation system. There is a need for the scientists, researchers and people to be provided with low cost measuring tools to measure all this criteria in order to further more the study of lightning activity throughout Earth‟s history. The common measurement tool that people usually use is a high speed camera came with a flash sensor. This method is very costly and has limitation as it only able to capture cloud to ground lightning and has a low mobility due to its heavy weight. Nowadays, intra-cloud lightning has become a hot topic. Thus, this project existed as an upgraded choice to replace high speed camera with affordable cost, high mobility but less accuracy compare to high speed camera.

ABSTRAK

Tesis ini menerangkan tentang pembangunan pemprosesan video masa sebenar mudah alih berdasarkan sensor kilat pada drone menggunakan raspberry pi. Sejak kebelakangan ini, kilat menjadi tanda tanya di kalangan ahli sains dan penyelidik kilat. Penyelidikan tentang kilat masih berlansung sehingga kini. Corak pergerakan kilat berubah mengikut masa masih tidak terjawab terutamanya sekali tentang kilat Narrow Bipolar Event (NBE). Untuk mengesan kilat adalah sangat susah, apabila ianya boleh berlaku bila-bila masa sahaja. Kilat boleh menyebabkan kematian dan berdasarkan rekod, kematian manusia akibat kilat boleh dikatakan sangat tinggi. Justeru, mengesan kilat amatlah penting bagi ahli sains dan penyelidik kilat untuk mengelak kilat dari menyambar kapal terbang atau bangunan. Proses menyelidik tingkah-laku kilat memerlukan banyak proses, dan salah-satunya adalah mengetahui corak perubahan kilat dengan mengambil gambar kilat sebanyak yang mungkin. Untuk mengambil gambar kilat dari awan ke tanah adalah sangat mudah dengan teknologi sekarang yang menggunakan kamera berkelajuan tinggi yang mahal. Namun begitu, kamera berkelajuan tinggi gagal menangkap gambar kilat di dalam awan. Oleh itu, projek ini menggantikan kamera berkelajuan tinggi untuk menangkap gambar kilat di dalam awan dengan kos yang lebih murah dan mobiliti yang tinggi.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF ABBREVIATIONS

NOIR	-	No Infrared
RPI	-	Raspberry Pi
NBE	-	Narrow Bipolar Event
CV	-	Computer Vision
EM	-	Electromagnetic
I/O	-	Input / Output
UAV	-	Unmanned Aerial Vehicle
UTeM	-	Universiti Teknikal Malaysia Melaka
MNF	-	Minimizing Noise Fraction
PSM	-	Projek Sarjana Muda
PNG	-	Portable Network Graphic
JPEG	-	Joint Photographic Expert Group
GIF	-	Graphic Interchange Format
UTC	-	Universal Time Coordinated
GMT	-	Greenwich Mean Time
SD	-	Secure Digital
FPS	-	Frame per second
RGB	-	Red, Green, Blue
HSI	-	Hue, Saturation, Intensity
2D	-	2-Dimension
3D	-	3-Dimension
QVGA	-	Quarter Video Graphic Array
PIC	-	Peripheral Interface Controller
CMOS	-	Complementary Metal-oxide Semiconductor
OS	-	Operating System
LCD	-	Liquid Crystal Display
USB	-	Universal Serial Bus
FKEKK	-	Fakulti Kejuteraan Elektronik dan Kejuteraan Komputer
DSLR	-	Digital Single-Lens Reflex
IoT	-	Internet of Things

CHAPTER I

INTRODUCTION

1.0 INTRODUCTION

This chapter describes the background of this project and the problems faced in real life of finding the right algorithm of drone-based lightning sensor that triggers the idea to develop this project. This chapter includes project background, problem statements, project objectives, project scopes and expected output from this project. In project background, the chapter gives a brief explanation about lightning. All the objectives and scopes of project have been covered with details in this chapter.

1.1 PROJECT BACKGROUND

Lightning is not a common thing that happens in our life. It is the occurrence of a sudden electrical discharge in a very short duration. There are two types of lightning that can be captured, cloud-to-ground and inter-cloud. A ground-based lightning network often leads to rejection of cloud-to-cloud lightning. One of the most mystery lightning is intra-cloud lightning. Our project mostly will cover this lightning type.

Figure 1.0: The image of intra-cloud lightning [1]

Sprites are one of the large-scale electrical discharges that happen high above thunderstorm clouds. They are triggered by the discharges of positive lightning between an underlying thundercloud and the ground [1]. Sprites are sometimes inaccurately called upper-atmospheric lightning. However, sprites are cold plasma phenomena that

lack the hot channel temperatures of tropospheric lightning, so they are more akin to fluorescent tube discharges than to lightning discharges.

Optical imaging using a 10,000 frame-per-second high speed camera shows that sprites are actually clusters of small, decameter-sized (10–100 m or 33–328 ft) balls of ionization that are launched at an altitude of about 80 km and then move downward at speeds of up to ten percent the speed of light, followed a few milliseconds later by a separate set of upward moving balls of ionization.

Lightning can strike in a variety of colours. The most common colour of lightning is white, but lightning can actually appear red, yellow, green, even blue or purple. Commonly people use flash sensor to do photograph lightning by using DSLR camera [2]. However, this method required expensive equipment and too heavy to carry on drone. Besides, the camera alone do not has any processor to do real time video processing to get satisfy output. The Raspberry Pi is a tiny and affordable computer that can use OpenCV (Open Source Computer Vision) to run video processing script. OpenCV is a library of programming functions mainly aimed at real-time computer vision.

1.2 PROBLEM STATEMENTS

Analysis on the pattern of lightning flash (images of evolution of lightning flash) attracts the attention of researchers for many years. Traditionally, researcher use hot air balloon to capture the image of sprite. However, such approach is not proper when dealing with a limited budget and considering the pro and cons of the project. The hot air balloon is not controllable and has a high possibility of vanish on air. Usually, people capture the lightning image on the ground. Community found difficulties to capture image in the cloud with harsh environment (strong wind).

1.3 OBJECTIVES

The objectives of the project are:

1. To investigate suitable algorithm to be implemented on video processing for lightning detection in harsh environment.
2. To program a low-cost camera to a higher frame rate per second (target is 1000 fps) for lightning sensor.
3. To evaluate and test the performance of the developed technique.

1.4 SCOPES

1.4.1 Data

The data used in this project are in type of image. At the start, the image should be taken by UAV drone belongs to a degree student, Sulaiman. Unfortunately, the drone does not functioning well. So, the camera will be put on the Block C FKEKK‟s rooftop. The height 50 meter of image taken is parameters that has been fix for every image. In this project, 200 images are taken to compare the result in order to analyse the accuracy in next chapter later. Figure 1.1 below shows the UAV drone that supposedly to be used in order to take the image from above overview.

Figure 1.1: UAV Drone

1.4.2 Study area

The study area for this project is at the potential place for lightning to occur around Melaka. The project chooses Universiti Teknikal Malaysia Melaka (UTEM) as the main study area. This is due to the high potential of the place to see lightning around the scene. As an alternative method to capture lightning, a testing environment has been setup. A black box with an installed electric racket has been setup in the laboratory to help testing the algorithm. Figure 1.1 shows the overview of UTeM where the image taken for the real data.

Figure 1.2: Overview of UTEM night scene.

1.4.3 Hardware

The project is free from any external sensor on raspberry pi except pi camera sensor. In this thesis, we only focus on the maximum usage and capability of the camera sensor alone compare to other specific hardware sensor like flash sensor.

1.4.4 Algorithm

The algorithm must provide a good solution on maintaining the original lightning image. This is because a good sample of original lightning image can help the scientist or lightning researcher to do the research base on scientific and exact data. A fake or wrong original data can make researcher confuse to conclude any hypothesis.

1.4.5 Time for data collection

The project is focusing only at night. This is because the most suitable time to collect data is when there is no sunlight appears on the UTeM scene. The sunlight can produce noise to the project system. Thus, the data captured during day may lead to produce wrong data.

1.5 PROJECT SIGNIFICANCE

Nowadays, the image of lightning can only be captured mainly by depending on high speed camera using a programmed lightning detection feature. Obviously, the traditional method use is really costly and almost unaffordable for every researcher to buy the equipment. Furthermore, the camera able to capture only at ground and is not compatible to bring it up to the cloud. Therefore, this project attempts to duplicate a high speed camera that is able to capture lightning and improving it flexibility to bring it everywhere.

By using of this project, researcher can do further study on the behaviour of lightning and solve the mystery of the thunder lightning in the air. The mystery of how lightning begins in clouds may have been solved, but there are some riddles that still questionable. From the benefit of this project, researcher can save their cost and time to monitor the lightning. Thus, this system might contribute a significance advantage to the researcher to ease their research and find the exact figure of intra-cloud lightning.

1.6 SUMMARY

This project purpose is to build new algorithm for real time video processing for drone-based lightning detection. The project makes use of remote capturing data to detect and store the image of lightning in the storage. Hence, this project can give an alternative solution for the researcher to capture the image of intra cloud lightning instead of just capturing cloud to ground lightning. They also can save their budget by not buying an expensive high speed camera to capture lightning image.